SOV/56-37-2-30/56

24(3)

AUTHORS: Bychkov, Yu. A., ~~Gurevich, L. E.~~, Nedlin, G. M.

TITLE: Thermoelectric Phenomena in Strong Magnetic Fields in Metals With Different Fermi Surfaces

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 37, Nr 2(8), pp 534-539 (USSR)

ABSTRACT: This is an accurate investigation of several thermoelectric phenomena on the basis of the quasiclassical theory of the kinetic phenomena in metals placed in strong magnetic fields developed by I. M. Lifshits, M. Ya. Azbel' and M. I. Kaganov. If an electric field and a temperature gradient exist in the metal, the distribution function f of the particles is no longer given by $f_0 = \left\{\exp\left[(\varepsilon - \mu)/kT\right] + 1\right\}^{-1}$, but it differs from f_0 by a certain quantity f_1, i.e. $f = f_0 + f_1$ is a solution of the corresponding kinetic equation. The existence of the additional term f_1 causes the current density vector $\vec{j}$ and the thermal flux vector $\vec{q}$ to differ from zero. They are related to f_1 by the following expressions:

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$\vec{j} = \frac{2e}{(2\pi\hbar)^3}\int \vec{v}f_1 dp$, $\vec{q} = \frac{2}{(2\pi\hbar)^3}\int (\varepsilon - \zeta)\vec{v}f_1 dp$. In the general case $\vec{j}$ and $\vec{q}$ may be written as follows:

$$j_i = \frac{a_{ik}}{T}E_k + b_{ik}\frac{\partial}{\partial x_k}\left(\frac{1}{T}\right), \quad q_i = \frac{c_{ik}}{T}E_k + d_{ik}\frac{\partial}{\partial x_k}\left(\frac{1}{T}\right).$$

In the presence of a magnetic field the kinetic coefficients are functions of the vector $\vec{H}$. The asymptotic behavior of a thermoelectromotive force in a strong magnetic field is studied. If the dependence of the α_{ik} upon $\vec{H}$ is known, it is easy to obtain the asymptotic characteristics β_{ik} and μ_{ik} by applying the symmetry relations. Actually, the asymptotic characteristics of the Peltier-coefficients are everywhere determined first. In the first section of this article the case of a closed Fermi surface is discussed. In order to determine the dependence of the tensor β_{ik} upon the magnetic field strength, the

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behavior of the quantities a_{ik} and c_{ik} must be known. The authors make recourse extensively to the results of the papers by I. M. Lifshits and V. G. Peschanskiy (Ref 2). In this section the following two possibilities are investigated: a) The number of particles and holes is not equal. b) These numbers are equal. Explicit expressions for the tensor β_{ik} are derived for both cases. In the second section the case of a closed Fermi surface is investigated. The behavior of the thermoelectric coefficients near the following special directions of the magnetic field is studied: a) The magnetic field is so directed that a layer of open trajectories exists forming a unidimensional set; b) The directions of the magnetic field forming open trajectories constitute a two-dimensional domain; c) The vector has a distinguished direction in the domain of the open trajectories, if the trajectories are closed. The tensors a_{ik}, c_{ik} and β_{ik} are written down explicitly. By this method the character of the asymptotic behavior of the thermoelectric coefficients near all three kinds of

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singularities have been determined. The authors express their gratitude to Academician L. D. Landau for discussing the work, Yu. A. Bychkov also expresses his gratitude to I. M. Khalatnikov and I. M. Lifshits for valuable discussions. There are 4 Soviet references.

ASSOCIATION: Institut fizicheskikh problem Akademii nauk SSSR (Institute of Physical Problems of the Academy of Sciences, USSR) Leningradskiy fiziko-tekhnicheskiy institut Akademii nauk SSSR (Leningrad Physical and Technical Institute of the Academy of Sciences, USSR)

SUBMITTED: March 19, 1959

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SOV/56-37-3-27/62

24(3)

AUTHORS: Gurevich, L. E., Nedlin, G. M.

TITLE: The Thermoelectric Coefficients of Metals in Strong Magnetic Fields and the Effect of Electron Entrainment by Phonons

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 37, Nr 3(9), pp 765-775 (USSR)

ABSTRACT: The present paper aims at investigating the behavior of the thermoelectric tensor in strong magnetic fields if the electron Larmor frequency is greater than the collision frequency; for this purpose the authors make use of the methods suggested by Lifshits, Azbel', and Kaganov. Lifshits and Peschanskiy (Ref 3) already investigated the asymptotic behavior of the thermoelectric tensor in strong magnetic fields, without, however, taking the effect of electron entrainment by phonons into account. This is now done in the present paper. Considerations apply to the range of low temperatures, where $T \ll \Theta$ (Θ is the characteristic Debye temperature and T the temperature of the sample). In the first part of the paper the linearized equations of motion for the electron- and phonon

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distribution functions are investigated; the existence of a temperature gradient, a gradient in chemical potential, and of a magnetic field in the z-direction are assumed. These equations are investigated inter al. with respect to phonon drift velocity. The second part of the paper deals with the solution of the equation of motion in the case of a scattering of the electrons on lattice defects and of electrons among one another. The following 3 cases are dealt with separately: 1) Closed trajectories with ε = const and p_z = const, which are within the boundaries of a lattice cell. 2) Open trajectories, and 3) approximation to the "critical direction" (Lifshits, Peschanskiy) for closed and open trajectories. In the third part of this paper the scattering of electrons on phonons is finally investigated. It was found that the effect of the increase of the number of electrons by phonons considerably changes the asymptotic values of the tensor for high field strengths, and also its dependence on the magnetic field direction with repsect to the crystal axis (in the case of

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complex topology of the Fermi surface). There are 8 Soviet references.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut Akademii nauk SSSR (Leningrad Physico-technical Institute of the Academy of Sciences, USSR)

SUBMITTED: April 4, 1959

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24(0) SOV/53-67-4-7/7

AUTHOR: Chentsov, R.

TITLE: The Fifth All-Union Conference on the Physics of Low Temperatures (5-ye Vsesoyuznoye soveshchaniye po fizike nizkikh temperatur)

PERIODICAL: Uspekhi fizicheskikh nauk, 1959, Vol 67, Nr 4, pp 743-750 (USSR)

ABSTRACT: This Conference took place from October 27 to November 1 at Tbilisi; it was organized by the Otdeleniye fiziko-matematicheskikh nauk Akademii nauk SSSR (Department of Physico-mathematical Sciences of the Academy of Sciences, USSR), the Akademiya nauk Gruzinskoy SSR (Academy of Sciences, Gruzinskaya SSR), and the Tbilisskiy gosudarstvennyy universitet im. Stalina (Tbilisi State University imeni Stalin). The Conference was attended by about 300 specialists from Tbilisi, Moscow, Khar'kov, Kiyev, Leningrad, Sverdlovsk, and other cities as well as by a number of young Chinese scientists at present working in the USSR. About 50 lectures were delivered which were divided according to research fields. -

II. Supraconductivity. 13 lectures were delivered on this field of which two were experimental and the others theoretical. Reports on experimental investigations of supraconductivity were delivered by Yu. V. Sharvin and V. F. Gantmakher (IFP) and N. V. Zavaritskiy (IFP). The former investigated the structure of the intermediate state in monocrystals of pure

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tin, the latter measured the thermal conductivity of differently shaped orientated cylindrical gallium samples at 0.1 - 4.2°K. A. A. Abrikosov, L. P. Gor'kov and I. M. Khalatnikov (IFP) theoretically investigated the behavior of a superconductor in the high-frequency field. V. L. Ginzburg and G. F. Zharkov (FIAN) dealt with the microscopical theory, and Ginzburg discussed among other things the part played by fluctuations in phase transitions of the second kind. I. M. Lifshits (KhFTI) showed that it follows from the modern theory of supraconductivity in consideration of the anisotropy of metals that, in principle, the existence of supraconductors is possible which are supra-conductive only within a limited range of temperature (and not at all temperatures below the critical ones). B. T. Geylikman and V. Z. Kresin (IAE) investigated the electron- and phonon thermal conductivity of supraconductors by means of the microscopical theory at temperatures that are not very near absolute zero. M. V. Buykov and L. E. Gurevich (FTI AN SSSR) spoke about the surface energy on the boundary between the supraconductive and normal phases. D. N. Zubarev and Yu. A Tserkovnikov (Matematicheskiy institut AN SSSR - Mathematics Institute AS USSR) dealt with

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the thermodynamics of the supraconductive state (Froehlich-model), V. V. Tolmachev (MIAN) investigated the problem of collective excitations in a supraconductor. D. V. Shirkov (Ob"yedinennyy institut yadernykh issledovaniy - Joint Institute of Nuclear Research) spoke about consideration of Coulomb-interaction of electrons in semiconductors. The problem of consideration of the Coulomb interaction was discussed by Chen' Ch'un-hsien and Chou, Hsi-hsin (KNR).

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S/181/60/002/06/32/050
B006/B056

24.3950

AUTHORS: Gurevich, L. E., Uritskiy, Z. I.

TITLE: The Theory of Infrared Absorption of Crystals

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 6, pp. 1239 - 1249

TEXT: Longwave radiation can be absorbed in crystals, both if $\omega < E_0/\hbar$ (where E_0 denotes the width of the forbidden band) and within the internal photoeffect. In the present paper, the absorption of longwave radiation is investigated at frequencies $\omega < \omega_0$ (ω_0 - photoeffect threshold) and in the region of self-absorption. In this connection the absorption with the formation of virtual electron-hole pairs in the crystal (the pairs are annihilated under the formation of one or several phonons) is investigated, as well as absorption by free carriers in the homogeneous magnetic field and absorption in the magnetic field within the region of the internal photoeffect. In the first chapter of this paper, absorption in phonon production is studied. This so-called phononic absorption is investigated for atomic crystals. It is shown that photon absorption under the formation

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of two phonons is the most frequently observed both in the region of continuous absorption and in the resonance lines which are connected with the combination of phonons of different branches. This absorption coefficient (for the absorption on resonance lines) at frequencies which are equal to sums of cutoff frequencies of two arbitrary branches, is not a monotonic or smooth function of the frequency. In the second chapter, the absorption by free carriers in the magnetic field is investigated within the region of diamagnetic resonance $(\omega \gg \Omega)$; it is shown that oscillations of the absorption coefficient occur with different periods and that, besides, the absorption coefficient has an anisotropy which depends on the orientation of the magnetic field with respect to photon polarization. The oscillations of the absorption coefficient occur both when degeneration exists and if there is no degeneration but if the magnetic field is strong $(\hbar\Omega \gg T$, Ω - Larmor frequency, T - temperature in energy units). In the region of self-absorption in a magnetic field, the oscillation of the absorption coefficient is obtained as a function of $(\omega - \omega_0)/\Omega$ with a period equal to unity. In the case of degeneration, the absorption edge shifts and oscillates as a result of Fermi level oscillation. Absorption

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is hardly influenced by temperature. In the last part of the paper, which deals with absorption within the region of the internal photoeffect, it is shown that the shift of the absorption bands occurring in the case of electron or hole degeneration depends on the photon polarization relative to the magnetic field and has a step-like character at $e_{\parallel} = 0$. Ye. F. Gross, B. P. Zakharchenya, P. P. Pavinskiy, V. S. Mashkevich, K. B. Tolpygo, S. I. Pekar, I. M. Livshits, and A. M. Kosevich are mentioned in the paper. There are 15 references: 6 Soviet, 7 American, 1 German, and 1 British.

ASSOCIATION: Fiziko-tekhnicheskiy institut (Physicotechnical Institute). Pedagogicheskiy institut im. A. I. Gertsena, Leningrad (Pedagogical Institute imeni A. I. Gertsen, Leningrad)

SUBMITTED: October 12, 1959

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82995
S/181/60/002/008/014/045
B006/B070

24.7500

AUTHORS: Gurevich, L. E., Vladimirov, V. I.

TITLE: The Kinetic Theory of Strength

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 8, pp. 1783-1792

TEXT: In order to explain the dependence of the time of rupture on the stress applied to a solid body, S. N. Zhurkov and others (Refs. 1-4) developed a theory according to which the state under load is already a non-equilibrium state and the rupture process begins before the critical stress is reached, and proceeds with a finite rate. Rupture is always accompanied with plastic deformation which takes place both before and during the fissure formation. The authors of the present paper have now developed a theory of the rupture process for solid bodies. The theory is based on the assumption that the fissures originate at the end of a slipping band in the layer between the grains. The results of the theory agree with those of Zhurkov. The fact that in a real crystal rupture occurs under a stress several orders of magnitude lower than the

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value for solid bodies, is explained in different ways. The authors discuss here the hypothesis of Griffits, the hypothesis of endurance, and the ideas based on the dislocation theory, and point some flaws in them. The energetic problem of fissure formation is discussed according to a theoretical consideration of the stress concentrations in the intermediate layers. The following conclusions are obtained: (1) For $\sigma < \sigma_0\left(\frac{a}{d}\right)^{3/4}$, fissure formation is energetically unfavorable and so does not occur. (2) For $\sigma_0\left(\frac{a}{d}\right)^{3/4} < \sigma < \sigma_0\left(\frac{a}{d}\right)^{1/2}$, stress at the edge of the fissure $\sigma_n' = \sigma\sqrt{d/a}$; $\sigma_0\sqrt{a/d} < \sigma_n' < \sigma_0$ is smaller than the critical stress and the rupture process proceeds with a velocity that is small compared to the velocity of sound. (3) For $\sigma > \sigma_0\sqrt{a/d}$ the stress at the edges of the fissures is larger than the critical stress and the fissure will increase with a velocity of the order of the velocity of sound (a - lattice constant, d - polycrystalline grain dimension). A determination

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of the time required for the rupture of a sample leads to expression (15) which is the same as that obtained by Zhurkov. The authors thank S. N. Zhurkov, V. R. Regel', and A. N. Orlov for discussions. B. Ya. Pines and T. P. Sanfirova are mentioned. There are 5 figures and 15 references: 10 Soviet, 3 British, and 2 US.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR Leningrad (Institute of Physics and Technology of the AS USSR, Leningrad)

SUBMITTED: February 16, 1960

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16.8100

77327
SOV/57-30-1-6/18

AUTHORS: Gurevich, L. E., Pavlov, S. T.

TITLE: Scattering of Electromagnetic Waves by Free Electrons in a Strong Magnetic Field

PERIODICAL: Zhurnal tekhnicheskoy fiziki, 1960, Vol 30, Nr 1, pp 41-43 (USSR)

ABSTRACT: The authors present the resonance cross section for the limiting cases of $k_o a << 1$ and $ka >> 1$. The scattering of photon $\mathbf{K}_o$, θ_o (polarization unit vector) at electrons with two-dimensional wave vector $\boldsymbol{\rho}_o$ and quantum number n_o in a magnetic field $H_o = H_{oz}$, transfers the system into a state $\mathbf{K}$, $\mathbf{e}$ and $\boldsymbol{\rho}$, n. $\mathbf{K}$ and $\mathbf{k}_o$ are wave vectors of the incoming and scattered wave. One can write $k_{ox} = p_{ox} = p_{oz} = 0$, and the perturbation Hamiltonian takes the form

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$$H = H_1 + H_2,$$

$$H_1 = -\frac{e}{mc}(\mathbf{pA}) + \frac{e^2}{mc^2}(\mathbf{AA}_0),$$

$$H_2 = \frac{e^2}{2mc^2}(\mathbf{A})^2; \qquad \mathbf{A}_0 = \mathbf{A}_0(-y\mathcal{H}_0, 0, 0). \qquad (2)$$

The spin does not add significant contribution to the scattering in cases discussed by the authors. The effective cross section is

$$d\sigma = \frac{2\pi}{\hbar c} K^2 \rho, \qquad (3)$$

where ρ is energy density of final states; K is matrix element between the initial and final states calculated for H_1 in the second and for H_2 in the first approximation of the perturbation theory. In the limiting case of long waves when

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$$k_0 a \ll 1 \left(a = \sqrt{\frac{ch}{e\mathcal{H}_0}} \right.$$

is quantity characterizing the size of the magnetic oscillator), the authors obtained

$$d\sigma(n_0+1, n_0) = \frac{r_0^2}{4} do \frac{h\Omega}{mc^2} \frac{n_0+1}{\left(1-\frac{2\Omega}{\omega_0}\right)^2} \times$$

$$\times (1-\cos^2\alpha)[1+(\cos\alpha\cos\theta+\sin\alpha\sin\theta\cos\varphi)^2], \qquad (4)$$

$$d\sigma(n_0-1, n_0) = \frac{r_0^2}{4} do \frac{h\Omega}{mc^2} \frac{n_0}{\left(1-\frac{\Omega}{\omega_0}\right)^2} \times$$

$$\times (1+\cos^2\alpha)[1-(\cos\alpha\cos\theta+\sin\alpha\sin\theta\cos\varphi)^2]. \qquad (5)$$

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where Ω is Larmor frequency; ω_0 is frequency of the incoming wave; r_0 is classical electron radius, θ_z is angle between $\mathbf{k}_0$ and $\mathbf{k}$; φ is angle between the plane $(\mathbf{k}_0, \mathcal{H}_0)$ and $(\mathbf{k}_0, \mathbf{k})$; α is angle between $\mathbf{k}_0$ and $\mathcal{H}_0$. Because of the factor $\frac{\hbar\Omega}{mc^2}$, incoherent scattering is significant only near the resonance. $d\sigma(n_0 n_0)$ is identical with the classical expression. In the limit $ka \gg 1$, $\frac{\Omega}{\omega_0} \ll 1$. Now the cross section is of the form:

$$d\sigma_{(n, n_0)} = \frac{1}{2} r_0^2 do \frac{k}{k_0} (1 + \cos^2 \theta) \frac{|I_{nn_0}(\xi)|^2}{\pi \cdot 2^{n+n_0} n! n_0!}. \qquad (6)$$

Here $\xi = \frac{1}{2} a^2 [k_x^2 + (k_{0y} - k_y)^2]$, I_{nn_0} — integral of the form

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$$I_{mn}=\int_{-\infty}^{\infty} d\zeta \exp\left[-\frac{1}{2}(\zeta-\zeta_0)^2-\frac{1}{2}(\zeta-\zeta')^2+ika\zeta\right]\times \times H_m(\zeta-\zeta_0)H_n(\zeta-\zeta'), \tag{7}$$

where H_m, H_n are Hermite polynomials of appropriate order. I_{mn} is given by

$$I_{mn}=2^{\frac{m+n}{2}}\sqrt{\pi}\left[\frac{k^2a^2+(\zeta_0-\zeta')^2}{2}\right]^{\frac{n-m}{2}}L_m^{n-m}\left[\frac{k^2a^2+(\zeta_0-\zeta')^2}{2}\right]\times \times\exp\left\{-\frac{1}{2}\left[\frac{k^2a^2+(\zeta_0-\zeta')^2}{2}\right]+\frac{1}{2}ika(\zeta_0+\zeta')+ i(m-n)\operatorname{arctg}\frac{ka}{\zeta_0-\zeta'}\right\}; \quad n\geqslant m, \tag{8}$$

$$I_{mn} = 2^{\frac{m+n}{2}} \sqrt{\pi} \left[\frac{k^2 a^2 + (\zeta_0 - \zeta')^2}{2} \right]^{\frac{m-n}{2}} L_n^{m-n} \left[\frac{k^2 a^2 + (\zeta_0 - \zeta')^2}{2} \right] \times$$
$$\times \exp \left\{ -\frac{1}{2} \left[\frac{k^2 a^2 + (\zeta_0 - \zeta')^2}{2} \right] + \frac{1}{2} ika(\zeta_0 + \zeta') + \right.$$
$$\left. + i(m-n) \operatorname{arctg} \frac{ka}{\zeta' - \zeta_0} \right\}; \quad m \geqslant n. \tag{9}$$

where L_m^{n-m}, L_n^{m-n} are Laguerre polynomials. In the absence of degeneration and with $\mu \mathcal{H}_0 >> kT$, $n_0 = 0$, one obtains

$$d\sigma(n, 0) = \frac{1}{2} r_0^2 (1 + \cos^2 0)\, do \frac{1}{n!} \xi^n e^{-\xi}. \tag{10}$$

Its largest value is for $n = \xi$, and, therefore, the degree of incoherency depends on the direction of

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observation. In the case of strong degeneracy with $E_F \gg \mu \mathcal{H}_o \gg kT$, $n_o \gg 1$. Investigation shows that coherent scattering is then the most probable. There is 1 U.K. reference, W. Heitler, Quantum Theory of Radiation, IL (1956).

ASSOCIATION: Physico-technical Institute AS USSR, Leningrad C. (Fiziko-tekhnicheskiy institut AN SSSR, g. Leningrad)

SUBMITTED: July 20, 1958

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28095

S/181/61/003/009/029/039
B104/B102

24.2700 (1043,1160,1537)

AUTHORS: Gurevich, L. E., and Nedlin, G. M.

TITLE: Thermo-emf of semiconductors in a quantizing magnetic field with account of the entraînement of electrons by phonons

PERIODICAL: Fizika tverdogo tela, v. 3, no. 9, 1961, 2779-2790

TEXT: The thermo-emf has been studied for a non-degenerate electron gas. The entraînement of electrons by phonons in a strong, quantizing magnetic field H ($\hbar\omega > T$, where ω denotes the electron Larmor frequency) has been taken into account. The magnetic field is assumed to be perpendicular to the temperature gradient. In an unevenly heated crystal phonons interact with electrons and an oriented flow of the latter arises. This entraînement of electrons by phonons has been studied jointly with the effect of the temperature gradient on the electrons while determining the thermo-emf. For a case where an electric field $\vec{E}$, a temperature gradient ∇T, and a gradient of the chemical potential $\nabla\zeta$ exist, the total current j_i is calculated as

$$j_i = \sigma_{ik}E'_k - \beta_{ik}\nabla_k T \text{ with } \vec{E}' = \vec{E} - \frac{1}{e}\nabla\zeta, \text{ and}$$

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Thermo-emf of semiconductors ...

$E_i' = \alpha_{ik} \nabla_k T = (\sigma^{-1}\beta)_{ik} \nabla_k T$. The tensors σ and β are calculated, and the
phonon distribution function is set up. Detailed studies show that the
following inequality will hold for semiconductors if the magnetic field is
not too strong ($H < H_0 \simeq 10^4 T^2$ oersteds) and if the condition $\hbar\omega/T > 1$ is
satisfied:

$$\frac{\hbar\omega}{T} \cdot \frac{ms^2}{T} < 1,$$

where m denotes the effective electron mass, and s
the velocity of sound. In this case, the Herring mechanism is valid and
the electrons interact with long-wave phonons, which are relaxing on
short-wave (thermal) phonons. The thermo-emf due to entraînement in
magnetic fields is greater by a factor of $\hbar\omega/T$ than the thermo-emf due to
entraînement without magnetic field. In superhigh magnetic fields ($H \gtrsim H_0$),
however, the electrons interact also with thermal phonons. In this case,
the hydrodynamic analogy suggested by C. Herring (Phys. Rev., 96, 1163,
1954; 95, 954, 1954) is not valid. The thermo-emf is no more a function of
the magnetic field. The model of Herring has to be replaced by another one
or modified, which is done in the last section of this paper. It is
assumed that no momentum is lost in phonon-phonon interaction; such an

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interaction only equalizes the phonon drift velocities. With the help of a hydrodynamic model it is shown that for this case the thermo-emf due to electron entraînement is no longer a function of the magnetic field. There are 1 figure and 11 references: 7 Soviet and 4 non-Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR Leningrad (Institute of Physics and Technology imeni A. F. Ioffe, AS USSR, Leningrad)

SUBMITTED: February 6, 1961 (initially), May 3, 1961 (after revision)

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22133

S/056/61/040/003/013/031
B102/B205

24.4500

AUTHORS: Gurevich, L. E., Nedlin, G. M.

TITLE: Quantum-kinetic equation in the presence of mutual dragging of electrons and phonons

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 40, no. 3, 1961, 809-818

TEXT: The significant role played by the deviation of the phonon-distribution function from equilibrium (i.e., the effect of mutual dragging of electrons and phonons) in thermoelectric phenomena has already been pointed out by Gurevich (ZhETF, 16, 193, 1946) and C. Herring (Phys.Rev. 96, 1163, 1954). In doing so, the two afore-mentioned authors proceeded from Boltzmann's equations of motion for the phonon- and electron-distribution functions, taking into account the fact that the two systems were out of equilibrium. The problem is essentially different in the case of energy quantization where the distance between the discrete levels is larger than or comparable to $T = \beta^{-1}$ (T - temperature in energy units). This problem is the subject of the present paper. First of all,

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Quantum-kinetic equation...

the system of kinetic equations for electrons and phonons in a quantized magnetic field is derived. A crystal is considered with the aid of an electron spectrum $\varepsilon(\vec{P})$ in a magnetic field $\vec{H} = (0,0,H)$. Thus, the energy operator can be written as $\hat{\varepsilon} = \varepsilon(\hat{P}_x,(eH/c)(\hat{x}_0-\hat{x}),\hat{P}_z)$, where $\hat{x}_0 = (c/eH)\hat{P}_y$. Then, the corresponding wave functions read $\psi = (L_y L_z)^{-1/2}\exp\left[(i\hbar)^{-1}(P_y y + P_z z)\right]\varphi_{nP_z}(x-x_0)$, where $L_{y,z}$ are the dimensions of the crystal in the y- and z-directions. φ obey the equation $\varepsilon(\hat{P}_x,-(eH/c)x,P_z)\varphi_{nP_z}(x) = \varepsilon_n(P_z)\varphi_{nP_z}(x)$, where $\varepsilon_n(P_z)$ stands for the eigenvalue of the energy ε_n. Thus, one has

$$\hat{\mathcal{H}} = \hat{\mathcal{H}}_0 + \hat{V};$$

$$\hat{\mathcal{H}}_0 = \sum_\alpha \hat{a}_\alpha^+ \hat{a}_\alpha \varepsilon_\alpha + \sum_q \hat{b}_q^+ \hat{b}_q \hbar\omega_q,$$

$$\hat{V} = \sum_q \sum_{\alpha\alpha'} \sum_l V_{ed}(q)\, J_{\alpha\alpha'}(q)\, \hat{a}_\alpha^+ \hat{a}_{\alpha'} \exp\left[-iqr_l/\hbar\right] +$$

$$+ \sum_q \sum_{\alpha\alpha'} (c_q \hat{b}_q J_{\alpha\alpha'}(q) + c_q^* \hat{b}_q^+ J^*_{\alpha'\alpha}(q))\, \hat{a}_\alpha^+ \hat{a}_{\alpha'} + \hat{V}_{ll} + \hat{V}_{ld}.$$

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for the total Hamiltonian of the system of electrons and phonons (without electron-electron interaction). α symbolizes the totality of the quantum numbers of the electron; $\omega_{\vec{q}}$ the angular velocity of a phonon of momentum $\vec{q}$; $V_{ed}(\vec{q})$ the Fourier component of the electron-defect interaction potential; $\vec{r}_j$ the coordinate of the j-th defect; $J_{\alpha\alpha'}(\vec{q})$ the matrix element of the operator $\exp[i\vec{q}\vec{r}/\hbar]$; $c_{\vec{q}}$ characterizes the electron-phonon interaction and is proportional to $q^{1/2}$ for small $\vec{q}$; $\hat{V}_{ff}$ and $\hat{V}_{fd}$ indicate the phonon-phonon and phonon-defect interaction operators, respectively. In the presence of a constant homogeneous field $\vec{E}$, the density matrix $\hat{\varrho}_1$ of the system will differ from the equilibrium density matrix $\hat{\varrho}_0$:

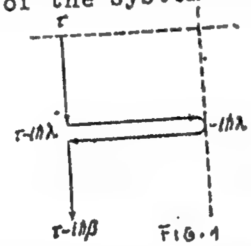

FIG.1

$$\hat{\rho}_1 = \hat{\rho}_0 \int_{-\infty}^{0} d\tau e^{s\tau} \int_0^{\beta} d\lambda \int d^3r\, e\hat{j}(r, \tau - i\hbar\lambda) E = \hat{\rho}_0 \int_{-\infty}^{0} d\tau e^{s\tau} \int_0^{\beta} d\lambda\, e\hat{v}(\tau - i\hbar\lambda) E, \quad s \to +0,$$

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Quantum-kinetic equation...

where $\hat{\vec{v}}$ denotes the velocity operator of the electron, and $\hat{\vec{J}}(\vec{r})$ the particle-flux density. The contour of integration in the single-particle matrices

$$f_{\beta'\beta} = \mathrm{Sp}\,\hat{\rho}_1 \hat{a}_\beta^+ a_{\beta'} =$$

$$= eE \sum_{\alpha\alpha'} (v)_{\alpha\alpha'} \int_{-\infty}^{0} d\tau e^{s\tau} \int_0^\beta d\lambda\, \mathrm{Sp}\left\{\hat{\rho}_0 T_C \left\{\exp\left[(i\hbar)^{-1}\int_C \hat{V}(z)\,dz\right](\hat{a}_\beta^+ \hat{a}_{\beta'})_{-i\hbar\lambda}(\hat{a}_\alpha^+ \hat{a}_{\alpha'})_\tau\right\}\right\}, \qquad (1.2)$$

$$g_{q'q} = \mathrm{Sp}\,\hat{\rho}_1 \hat{b}_q^+ \hat{b}_{q'} =$$

$$= eE \sum_{\alpha\alpha'} (v)_{\alpha\alpha'} \int_{-\infty}^{0} d\tau e^{s\tau} \int_0^\beta d\lambda\, \mathrm{Sp}\left\{\hat{\rho}_0 T_C \left\{\exp\left[(i\hbar)^{-1}\int_C \hat{V}(z)\,dz\right](\hat{b}_q^+ \hat{b}_{q'})_{-i\hbar\lambda}(\hat{a}_\alpha^+ \hat{a}_{\alpha'})_\tau\right\}\right\}.$$

according to O. V. Konstantinov and V. I. Perel' (Ref. 4: ZhETF, 39, 197, 1960) is illustrated in Fig.1. A set of kinetic equations for the phonon-distribution functions g and the electron-density matrix f (non-diagonal) is now obtained by the graph technique introduced in Ref. 4. Graphs for f and g are shown in Fig. 2. The corresponding equations are

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$$f_{\beta'\beta} = F_{\beta'\beta}(s + i\omega_{\beta'\beta})^{-1} + \sum_{\gamma'\gamma} W^{e}_{(\beta'\beta)(\gamma'\gamma)} f_{\gamma'\gamma}(s + i\omega_{\beta'\beta})^{-1} + \\ + \sum_{q'q} W^{ef}_{(\beta'\beta)(q'q)} g_{q'q}(s + i\omega_{\beta'\beta})^{-1},$$

$$g_{q'q} = G_{q'q}(s + i\omega_{q'q})^{-1} + \sum_{\beta'\beta} W^{fe}_{(q'q)(\beta'\beta)} f_{\beta'\beta}(s + i\omega_{q'q})^{-1} + \\ + \sum_{r'r} W^{f}_{(q'q)(r'r)} g_{r'r}(s + i\omega_{q'q})^{-1}. \qquad (1.3)$$

The quantities W are kernels of "collision integrals" and have the meaning of transition probabilities. The relations for W, F, and G are likewise obtained from such graphs. They are fairly large and written explicitly. For the case of a strong transverse magnetic field ($\omega\tau \gg 1$), the system of equations for the diagonal parts of f and g is derived next.

$$i\omega_{\beta'\beta} f^{(n)}_{\beta'\beta} = F^{0\,(n)}_{\beta'\beta} - \Big(\sum_{\gamma'\gamma} W^{e}_{(\beta'\beta)\,(\gamma'\gamma)} F^{0\,(n)}_{\gamma'\gamma}(i\omega_{\gamma'\gamma})^{-1}\Big)^{(n)} + \Delta F^{(n)}_{\beta'\beta} + \\ + \Big(\sum_{\gamma'\gamma} W^{e}_{(\beta'\beta)(\gamma'\gamma)} f^{(n)}_{\gamma'\gamma}\Big)^{(n)} + \Big(\sum_{\gamma} W^{e}_{(\beta'\beta)\,(\gamma\gamma)} f^{d}_{\gamma\gamma}\Big)^{(n)} + \Big(\sum_{q} W^{ef}_{(\beta'\beta)\,(qq)}\, g_q\Big)^{(n)}, \qquad (2.1a)$$

$$-\sum_{\gamma'\gamma} W^{e}_{(\beta\beta)\,(\gamma'\gamma)} F^{0\,(n)}_{\gamma'\gamma}(i\omega_{\gamma'\gamma})^{-1} + \Delta F_{\beta\beta} + \sum_{\gamma'\gamma} W^{e}_{(\beta\beta)\,(\gamma'\gamma)} f^{(n)}_{\gamma'\gamma} +$$

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$$+\sum_{\gamma} W^{e}_{(\beta\beta)\,(\gamma\gamma)} f^{d}_{\gamma\gamma} + \sum_{q} W^{ef}_{(\beta\beta)\,(qq)}\, g_q = 0, \qquad (2.1б)$$

$$-\sum_{\gamma'\gamma} W^{fe}_{(qq)\,(\gamma'\gamma)} F^{0\,(n)}_{\gamma'\gamma} (i\omega_{\gamma'\gamma})^{-1} + \Delta G_q + \sum_{\beta'\beta} W^{fe}_{(qq)\,(\beta'\beta)} f^{(n)}_{\beta'\beta} +$$

$$+\sum_{\beta} W^{fe}_{(qq)\,(\beta\beta)} f^{d}_{\beta\beta} + \sum_{r} W^{f}_{(qq)\,(rr)}\, g_r = 0. \qquad (2.1в)$$

is obtained in place of (1.3). It is shown that, before solving the systems of integral equations for g and the diagonal part of f, an expansion in a power series of $(\omega\tau)^{-1} \ll 1$ (ω - Larmor frequency; τ electron-relaxation time) should be performed, the electron and phonon spectra being arbitrarily assumed. There are 9 figures and 7 references: 4 Soviet-bloc and 3 non-Soviet-bloc. The two references to English language publications read as follows: R. Kubo, J.Phys.Soc. Japan, 12, 570, 1957; E. N. Adams, T. D. Holstein, J.Phys.Chem.Solids, 10, 254, 1959.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut Akademii nauk SSSR (Leningrad Institute of Physics and Technology, Academy of Sciences USSR)

31796

S/056/61/041/006/047/054
B109/B102

24,7000 (1137, 1143, 1144, 1385)

AUTHORS: Gurevich, L. E., Efros, A. L.

TITLE: Effect of mutual dragging of electrons and phonons on the transverse electrical conductivity in a strong magnetic field

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 41, no. 6(12), 1961, 1978-1985

TEXT: It is shown that dragging of phonons by electrons changes the transverse electrical conductivity in a strong magnetic field at low temperatures ($T \ll \Theta$). A magnetic field H with $\omega\tau \gg 1$ is assumed to exist in the z-direction of a crystal. $\omega = eH/mc$, m is the effective electron mass, and τ is the electron relaxation time. The relaxation time τ_{Φ} in phonon-electron interaction is taken to be smaller than the relaxation time τ_{Φ} if phonons release their energy without participation of electrons. $\sigma_{Д}$ is taken to denote the so-called "defect conductivity", and σ_{Φ} the "phonon conductivity". Then, the transverse current consists of two components $j = j_1 + j_2$; j_1 is the part of current without dragging for

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which, according to L. E. Gurevich, G. M. Nedlin (ZhETF, 40, 809, 1961), the expression

$$j_1 = \frac{2\pi e}{V\hbar^3 T} \sum_{\alpha\beta q} |J_{\beta\alpha}|^2 |C_q|^2 N_q n_\alpha (1 - n_\beta)\, \delta(\omega_{\alpha\beta} + \omega_q)\, X^2_{\beta\alpha} eE. \qquad (1)$$

following from the phonon balance holds, while j_2 is given by

$$j_2 = \frac{2\pi e}{\hbar^2 V} \sum_{\alpha\beta q} |C_q|^2 |J_{\alpha\beta}|^2 n_\alpha (1 - n_\beta)\, \delta(\omega_{\beta\alpha} - \omega_q)\, X_{\beta\alpha} \frac{g_q}{N_q + 1}. \qquad (11)$$

which is related to phonon absorption and emission. In (11), α, β are the quantum numbers of an electron in a homogeneous magnetic field, n_α is the equilibrium Fermi function, N_q Planck's function, ω_q the phonon frequency, $J_{\beta\alpha}$ the matrix element of the operator $e^{i\vec{q}\vec{r}/\hbar}$, $\vec{q}$ the phonon momentum, $\vec{X}_{\beta\alpha} = \vec{X}^o_\beta - \vec{X}^o_\alpha$ is the displacement of the oscillator center on the transition from state α into state β, $C_q = E_o\sqrt{qa^3/MsV}$, E_o is the deformation potential, M the mass of a unit cell, s the sound velocity, and a the

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lattice constant. Deviation of the phonon distribution function from equilibrium:

$$g_q = -\frac{\tau_\Phi}{\tau_\Phi + \tau_{\Phi э}} N_q (N_q + 1) \frac{E}{H} \frac{cq_y}{T}. \qquad (9).$$

$$\sigma_\Phi = \frac{c^2}{H^2 TV} \sum_q q_y^2 N_q (N_q + 1)/(\tau_\Phi + \tau_{\Phi э}). \qquad (13)$$

is obtained accordingly. When considering the case of $\hbar\omega \ll \zeta$ and $2\sqrt{2m\zeta} > T/s$, ζ being the chemical potential,

$$\sigma_\Phi \approx \left(\frac{T}{ms^2}\right)^2 \left(\frac{T}{\hbar\omega}\right)^2 \frac{e^2}{a\Theta} \frac{s}{L}. \qquad (19)$$

holds, i.e., the electrical conductivity is a function of the specimen dimensions in y-direction which is perpendicular to the electrical and the magnetic field. In addition,

$$\frac{\sigma_\Phi}{\sigma_д} \sim 10 \left(\frac{T}{\Theta}\right)^4 \frac{1}{(na^3)^{4/3}} \frac{a}{Lx}. \qquad (22)$$

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For $T < \Theta$,

$$\sigma_\Phi \sim 10^2 \frac{e^2}{a\hbar} \frac{\Theta}{Ms^2}\left(\frac{T}{\hbar\omega}\right)^2\left(\frac{T}{ms^2}\right)^3 e^{-\Theta/\alpha T}, \tag{23}$$

holds. If $\hbar\omega \ll \zeta$ and $\sqrt{2m\zeta} < T/s$,

$$\sigma_\Phi \approx \frac{e^2}{\hbar a}\left(\frac{\zeta}{\hbar\omega}\right)^2 \frac{T}{Ms^2}\left(\frac{T}{\Theta}\right)^4.$$

If, however, $\hbar\omega \gg T$ and $\tau_\Phi = Aq^{-t}$, one obtains

$$\sigma_\Phi = \frac{c^2}{s^2}\frac{Tq_H^{t+2}\sqrt{8mT}}{H^2(2\pi\hbar)^3 A}\int\frac{\eta^{t+1}d\xi d\eta}{1 + C\xi\eta^{t-3}\exp(\xi^2+\eta^2)}, \tag{26}$$

where $\xi = q_z/\sqrt{8mT}$, $\eta = q_\perp/q_H$, $q_\perp^2 = q_x^2 + q_y^2$, $q_H^2 = 2eH\hbar/c$, $C = \left(\frac{T}{E_0}\right)^2 \frac{s}{\omega L}\frac{M}{m}\frac{1}{na^3}$.

The behavior of C indicates that the dragging effect is the stronger the higher electron concentration and the lower temperature are. As for semiconductors, scattering from impurity ions is significant:

$$\sigma_H \approx nNe^6/(mT)^{3/2}\omega^2\varepsilon^2. \tag{30}$$

$$\frac{\sigma_H}{\sigma_\Phi} \approx \frac{100}{\varepsilon^2}(nNa^6)\frac{e^4}{a^2T^2}\frac{L}{a}\left(\frac{q_H a}{\hbar}\right)^3\frac{\Theta}{T}. \tag{31}$$

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As a result a dragging effect may appear in magnetic fields of the order of 10 koe at about $10^{\circ}K$ with electron and defect concentrations of $N \sim n \sim 10^{14}/cm^3$. The experimental observation of this effect is based on the fact that the scattering by impurity ions causes a weak (evidently logarithmic) dependence of ϱ_{xx} on H. There are 5 references: 4 Soviet and 1 non-Soviet. The two references to English-language publications read as follows: E. Adams, T. Holstein. J. Phys. Chem. Sol., 10, 254, 1959; P. Klemens. Solid. St. Phys., 7, N.Y., 1958.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut Akademii nauk SSSR (Leningrad Physicotechnical Institute of the Academy of Sciences USSR)

SUBMITTED: July 21, 1961

Card 5/5

GUREVICH, L.E.; EFROS, A.L.

Effect of the mutual entrainment of electrons and phonons on the transverse electroconductivity in a high magnetic field. Zhur. eksp. i teor. fiz. 41 no.6:1978-1985 D '61. (MIRA 15:1)

1. Leningradskiy fiziko-tekhnicheskiy institut AN SSSR.
(Electric conductivity) (Magnetic fields)

39969

S/181/62/004/008/010/041
B125/B102

24,7000

AUTHORS: Gurevich, L. E., and Ipatova, I. P.

TITLE: Absorption of electromagnetic waves by homeopolar crystals

PERIODICAL: Fizika tverdogo tela, v. 4, no. 8, 1962, 2065-2074

TEXT: When temperatures are much lower than those of the forbidden band width $\hbar\Omega_0$ the photons absorbed by non-degenerate semiconductors or dielectrics are assumed to excite an electron from the filled band into the conduction band. When this electron is deexcited, it emits one or several phonons. The temperature T must be high enough to ensure that there is no appreciable absorption by free carriers. The emission of a single optical resonance phonon by an electron causes a resonance absorption at one of the optical threshold frequencies. As the electromagnetic waves are transverse, this absorption occurs only in non-cubic crystals and only in directions other than the main tensor axes of polarizability. In two-phonon absorption two phonons are formed, having the momenta $\vec{q}$ and $k-\vec{q} \simeq -\vec{q}$ of the two vibration branches t and t' with the frequencies $\omega_{t\vec{q}}$ and $\omega_{t'\vec{k}-\vec{q}} \approx \omega_{t'\vec{q}}$. From the transition probability

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$$W = (2\pi/\hbar^2)\sum_{tt'}\int d^3q\,|V_{tt'}(\vec{q})|^2\,\delta(\omega-\omega_{t\vec{q}}-\omega_{t'\vec{q}})$$ with $$V_{tt'}(\vec{q}) = -M_\mu^{tt'}(\vec{q})E_\mu$$

for the real part:

$$\mathrm{Re}\,\sigma_{\mu\nu}=\frac{\pi\omega}{\hbar}\sum_{tt'}\int d^3q\,[M_\mu^{tt'}(q)\,M_\nu^{tt'}(q)+M_\mu^{tt'}(q)\,M_\nu^{tt'}(q)]\times \times\delta(\omega-\omega_{tq}-\omega_{t'q}). \quad (2.7)$$

With t = t' only phonons from different branches can take part in the absorption. The finite width of the absorption line in non-cubic crystals is due to the anharmonic phonon interaction. With $T \ll h\Omega_0$ (where Ω_0 is the frequency in the atomic mass system) the band can be divided into a virtually empty and a filled band. The peak of resonance absorption is much more intense than the background of continuous absorption. Non-resonance absorption is due to many-phonon interactions with the lattice vibrations, but mainly to two-phonon interactions. For crystals with inversion center in the unit cell the selection rules of the qualitative theory apply and the following expressions govern the order of magnitude of the absorption coefficients:

$$\gamma' \simeq \frac{\mathrm{Re}\,\sigma'}{\omega} \simeq \left(\frac{e^2}{a}\frac{1}{\hbar\omega_0}\right)\left(\frac{E_2}{\hbar\Omega_0}\right)^2 \Lambda_2^4, \qquad (6.7)$$ and

$$\gamma'' \simeq \frac{\mathrm{Re}\,\sigma''}{\omega} \simeq \left(\frac{e^2}{a}\frac{1}{\hbar\omega_0}\right)\left(\frac{E_1}{\hbar\Omega_0}\right)^4 \Lambda_2^4. \qquad (6.8),$$

where E_1 and E_2 denote the real components of the electromagnetic field. For germanium $M = 1.6\cdot10^{-22}$ g, $\omega_0 \sim (1.3-1.7)\cdot10^{13}$ sec^{-1} and $a \sim 3\cdot10^{8}$ cm. Hence Λ_2 is $\sim(1-2)\cdot10^{-2}$. There are 5 figures.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute imeni A. F. Ioffe AS USSR, Leningrad)

SUBMITTED: March 8, 1962

24770d

S/181/62/004/007/037/037
B111/B104

AUTHORS: Gurevich, L. E., and Ioffe, V. I.

TITLE: The effect of current instability in semiconductors

PERIODICAL: Fizika tverdogo tela, v. 4, no. 7, 1962, 1979-1981

TEXT: Two solutions corresponding to the frequencies ω_1 and ω_2 are derived by linearization according to $n_1 = n - n_0$, $E_1 = E - E_0$ of the equations

$$\frac{\partial n_\pm}{\partial t} + \operatorname{div} \mathbf{j}_\pm = 0, \quad \operatorname{div} \mathbf{E} = \frac{4\pi e}{\varepsilon}[n_+ - n_-], \quad (1),$$

$$\mathbf{j}_\pm = -D_\pm\left(\nabla n_\pm \pm \frac{e\mathbf{E}n_\pm}{T}\right) - D'_\pm\left[\left(\nabla n_\pm \mp \frac{e\mathbf{E}n_\pm}{T}\right)\frac{\mathbf{H}}{H}\right] \quad (2)$$

on the assumption that $\alpha \ll 1$ and $j_x = 0$

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$$\omega_1 = \alpha (D_- + D_+)\left[\nabla n_0 \frac{k_x}{k^2} + i n_0\right] N^{-1} d^{-2};\quad \omega_2 = \frac{D_- D_+}{D_- + D_+} d^{-2} \times$$
$$\times \left[n_0^2 + \frac{\nabla n_0 k_x^2}{k^4}\right]^{-1} \left[\frac{\nabla n_0 k_x}{k^2} - i n_0\right] \left\{\frac{\nabla n_0}{k^2}\left(\frac{D'_-}{D_-} - \frac{D'_+}{D_+}\right) \times\right.$$
$$\left.\times \frac{e E_z d}{T} (h_x k_x k_z + h_y k_x^2 - h_y k_z^2)\right\}.$$

N is the equilibrium concentration, $\pm e\nu = \pm \varepsilon E/2\pi$ is the surface charge density on the basis of the Hall field, $n_0(x) = N\alpha e^{\alpha x/d}/2\mathrm{sh}(\alpha/2)$, $\alpha = H_y eEd(D'_-/D_- - D'_+/D_+)/HT$, d is the thickness of the plate considered (small compared with the other dimensions). The first solution decreases continuously, whereas the second increases continuously for real k. A complex criterion is established, stating when vibrations of frequency ω increase and when they do not. A formula is given for the case where vibrations of frequency ω arise, the surface of the plate is irradiated and the space charge is neglected, as it always can be in practice. The four most important English-language references are:

The effect of current instability ... S/181/62/004/007/037/037
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R. Larrbee, M. Steele, Appl. Phys., 31, 1519, 1960; M. Kikuchu, J. Phys. Soc. Japan, 17, 240, 1962; M. Kikuchu, J. Abe. J. Phys. Soc. Japan, 17, 241, 1962; R. Cardona, J. App. Phys., 33, 1826, 1962.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR Leningrad (Physicotechnical Institute imeni A. F. Ioffe AS USSR Leningrad)

SUBMITTED: April 3, 1962

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S/056/62/043/002/023/053
B104/B108

24.7700

AUTHORS: Gurevich, L. E., Efros, A. L.

TITLE: The effect of spin on the Shubnikov-de-Haas oscillations as a possible method of determining the effective mass of carriers

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 43, no. 2(8), 1962, 561-563

TEXT: The transverse electric conductivity of a semiconductor in a strong ($\Omega\tau \gg 1$) quantizing magnetic field ($\hbar\Omega \gg t$), $\mu H \gg T$) is

$$\sigma_{\perp} = \sum_{n,s\,n'} \frac{G_{nn's}(\zeta)}{\left[\zeta - \hbar\Omega\left(n+\frac{1}{2}\right)+s\mu H\right]^{1/2}\left[\zeta - \hbar\Omega\left(n'+\frac{1}{2}\right)+s\mu H\right]^{1/2}} \quad (4),$$

$$G_{nn's}(\zeta) \sim \int A_{nn'}(q)\, dq_x dq_y, \quad (5),$$

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The effect of spin on the...

where
$$\sqrt{2m\left(\zeta-\hbar\Omega\left(n+\tfrac{1}{2}\right)+s\mu H\right)}\pm\sqrt{2m\left(\zeta-\hbar\Omega\left(n'+\tfrac{1}{2}\right)+s\mu H\right)}.$$

This expression represents an oscillating function of $1/H$. ζ is the chemical potential, Ω the Larmor frequency, $\mu = e\hbar/2m_0c$, m_0 is equal to the mass of a free electron. The maxima of these Shubnikov-de-Haas oscillations, which correspond to different electron spin orientations, are shown to be mutually displaced as functions of $1/H$. The carrier effective mass can be determined from this mutual displacement.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe Akademii nauk SSSR (Physicotechnical Institute imeni A. F. Ioffe of the Academy of Sciences USSR)

SUBMITTED: February 27, 1962

Card 2/2

GUREVICH, L.E.; IOFFE, I.V.

On the appearance of current instability in semiconductors.
Fiz.tver.tela 4 no.10:2641-2646 O '62. (MIRA 15:12)

1. Fiziko-tekhnicheskiy institut imeni A.F.Ioffe AN SSSR, Leningrad.

(Semiconductors—Electric properties)

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S/181/62/004/010/001/063
B108/B186

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AUTHORS: Gurevich, L. E., and Ioffe, I. V.

TITLE: Current instabilities in semiconductors 1)

PERIODICAL: Fizika tverdogo tela, v. 4, no. 10, 1962, 2641-2646

TEXT: Current instabilities in semiconductors with intrinsic conductivity can arise when an electric (E_z) and a magnetic field are applied. If these are not parallel, instabilities will set in as soon as the fluctuations of the transverse Hall current and consequently of the local carrier concentration become too strong to be averaged out by diffusion. The criterion for current instabilities to arise in a thin plate (surface recombination dominant) is

$$\left\{\frac{eE_zd^2}{T}\frac{D_-D_+}{D_-+D_+}\left(\frac{D'_-}{D_-}-\frac{D'_+}{D_+}\right)\left[\gamma N+\frac{\gamma' eE_zH_y}{2TH}\left(\frac{D'_-}{D_-}-\frac{D'_+}{D_+}\right)\right]^{-1}\right\}^2\times$$

$$\times\frac{H_y}{2H}\left\{h_z\frac{\pi^2d^2}{L_yL_z}-h_y\frac{\pi^2d^2}{L_z^2}+2h_y\left[\gamma N+\frac{\gamma' eE_zH_y}{2TH}\left(\frac{D'_-}{D_-}-\frac{D'_+}{D_+}\right)\right]^{-1}\frac{D_-+D_+}{D_-D_+}\right\}>1$$

Card 1/4 1) SEE S/181/62/004/010/051/063

The frequency of such current oscillations is

$$\omega=\left(\frac{H_y}{H}\right)^2\left(\frac{D'_-}{D_-}-\frac{D'_+}{D_+}\right)^3\left(\frac{eEd}{T}\right)^3\frac{D_-D_+}{D_-+D_+}\left\{h_z\frac{\pi^2}{L_yL_z}-h_y\frac{\pi^2}{L_z^2}+\right.$$

$$\left.+h_y\left[\gamma N+\frac{\gamma' eEH_y}{2TH}\left(\frac{D'_-}{D_-}-\frac{D'_+}{D_+}\right)\right]\frac{D_-+D_+}{dD_-D_+}\right\}\times$$

$$\times\left\{\left[\gamma Nd+\frac{\gamma' eEdH_y}{2TH}\left(\frac{D'_-}{D_-}-\frac{D'_+}{D_+}\right)\right]\frac{D_-+D_+}{D_-D_+}\right\}^{1/2}\times$$

$$\times\left\{\left[\frac{\gamma Nd+\frac{\gamma' eEdH_y}{2TH}\left(\frac{D'_-}{D_-}-\frac{D'_+}{D_+}\right)}{\frac{D_-D_+}{(D_-+D_+)}}\right]^2+\left(\frac{eE_zdH_y}{TH}\right)^2\left(\frac{D'_-}{D_-}-\frac{D'_+}{D_+}\right)^2\right\}^{-1},$$

provided that $H_y \ll H_z$, $\frac{eH\tau}{mc}=\Omega\tau\ll 1$, where τ is the electron (hole) relaxation time. $D_{\pm}$ is the diffusion coefficient for electrons and holes, respectively, $D'_{\pm}$ are the Hall diffusion coefficients. d is the thickness of the plate in the x-direction. $\vec{h}$ is the unit vector in the direction

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Current instabilities in semiconductors

of $\vec{H}$, L_y and L_z are the length and the width of the plate, γ is the recombination coefficient for centers in the surface layer, γ' is the recombination coefficient for electrons (holes) with the charges $\pm e\nu = \pm \frac{\varepsilon T E_{0x}}{2\pi e d}$ that accumulate when a field is present near the surface, and arriving per cm^2. When the electrical and magnetic fields are parallel, and when incident light produces additional carriers, the condition for current oscillations of the frequency

$$\omega = \frac{eE_z d\pi^2}{TL_yL_z}\frac{D_-D_+}{D_-+D_+}\left(\frac{D'_-}{D_-}-\frac{D'_+}{D_+}\right)\left[\frac{D_-D_+}{\gamma Nd(D_-+D_+)}\right]^{1/2}$$

to arise is

$$\frac{j_0 eE_z d^2\pi^2}{2TL_yL_z}\left(\frac{D'_-}{D_-}-\frac{D'_+}{D_+}\right)\left[\frac{D_-D_+}{\gamma^2N^3(D_-+D_+)}\right]>1,$$

provided that volume charges can be neglected and that $n_+ = n_-$.

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Current instabilities in semiconductors

S/181/62/004/010/001/063
B108/B186

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute imeni A. F. Ioffe AS USSR, Leningrad)

SUBMITTED: April 6, 1962

Card 4/4

S/181/62/004/010/051/063
B102/B112

24.7700
24.2600

AUTHORS: Gurevich, L. E., and Ioffe, I. V.

TITLE: Some problems of the current in stability in semiconductors

PERIODICAL: Fizika tverdogo tela, v. 4, no. 10, 1962, 2964-2970

TEXT: This is the continuation of an earlier paper (FTT, v. 4, no. 10, 1962, 2637) in which the conditions for the occurrence of current instabilities in intrinsic semiconductors were studied. It has been found that if $j = j_z$ or if the face parallel to z is illuminated, an instability occurs at $h_y = H_y/H$. Further properties of this instability are studied. A study of the instability in the case of volume recombination of the carriers shows that in this case the field E_z applied to the semiconductor plate must be stronger, in order to cause self-excited oscillations, than is necessary without volume recombination. A study of the instability boundaries at high h_y shows that the instability occurs only in the angular interval $0.5-20^0$ between electric and magnetic field direction. For a

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strong magnetic field it is proved that self-excitation occurs only within a certain angular interval between electric and magnetic field. Further, the effect of the sample dimensions on the self-excitation conditions is studied. It is shown that oscillations occurring as a result of the presence of a Hall field can be extinguished by illuminating the lateral faces and that, conversely, illumination-induced oscillations can be extinguished by a Hall field. Finally, the self-excitation of oscillations in the case of different concentrations of positive and negative carriers is studied and the conditions for the occurrence of such oscillations are given.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute imeni A. F. Ioffe AS USSR, Leningrad)

SUBMITTED: June 27, 1962

S/181/62/004/010/034/063
B102/B112

AUTHORS: Gurevich, L. E., and Yassiyevich, I. N.

TITLE: Theory of the ferromagnetic Hall effect

PERIODICAL: Fizika tverdogo tela, v. 4, no. 10, 1962, 2854 - 2866

TEXT: A theory of the ferromagnetic Hall effect (FHE) is developed for ferromagnetic metals and atomic semiconductors since no general theory has hitherto been known. Only Luttinger (Phys. Rev. 112, 739, 1958) has studied quantitatively metals with inversion centers in the unit cell and calculated the FHE for T = 0. $I = I_z$, $B = B_z$ and $M = M_z$ are assumed for the current, the mean microscopic magnetic field, and the magnetization, respectively so that the equation $\vec{I} = \sigma\vec{E} + (\sigma'_B/B)[\vec{E}\vec{B}] + (\sigma'_M/M)[\vec{E}\vec{M}]$ which holds for the total current can be reduced to $E_y/I = R_B B + R_M M = (\sigma'_B+\sigma'_M)/[\sigma^2+(\sigma'_B+\sigma'_M)^2]$. R_B and R_M are the ordinary and the ferromagnetic Hall constants which are determined by the different types of carriers. The FHE is caused by the weak spin-orbit interaction of the conduction

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Theory of the ferromagnetic... S/181/62/004/010/034/063
B102/B112

electrons and depends on the different scattering and the different number of carriers with spins of different orientations. The degree of spin ordering of the conduction electrons is determined by the sum A of the exchange integrals. If electrons from different bands participate in the conduction, these exchange integrals may have different signs. For the s and d electrons of metals e.g., $A_d < 0$ and $A_s > 0$, i.e. the temperature dependent effects may be superimposed and the FHE may change its sign at a certain temperature. In semiconductors the holes (ferromagnetic band d) and the electrons (band s) are the carriers of the two zones. The studies were made over a wide range of temperature on the assumption that $\omega\tau \ll 1$, where $\omega = eB/mc$ and τ is the relaxation time. Separate studies were made for crystals with (B') and without (A') inversion center in the unit cell. For the latter the electron energy spectrum is assumed isotropic. First, the kinetic equation is set up and the Hall current $I = \frac{e}{V} Sp(\vec{v}^1 f^0 + \vec{v}^0 f^1)$ is calculated. $f = f^0 + f^1$ denotes the deviation from the equilibrium density ($\varrho = \varrho_0 + f$, ϱ_0 is the Gibbs distribution), $\vec{v} = \vec{v}^0 + \vec{v}^1$ is the velocity operator ($\vec{v} = \frac{i}{\hbar}[\vec{H},\vec{r}]$); if I is separated into I_n and I_d in correspondence

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with the off-diagonal and the diagonal elements of the density matrix, then expressions of the form

$$\mathbf{I}_d = -\left(\frac{e}{V}\right)\sum\left\{\mathbf{v}^1(ip, ip) f^0_{ip} + \mathbf{v}^0_{ip}\left(W^0_{ip,\, i'p'}\right)^{-1}\bar{R}^1_{i'p'}\right\}, \qquad (2, 12)$$

$$\mathbf{I}_n = -\left(\frac{e}{V}\right)\sum\left\{\left[\frac{\mathbf{v}^1(ip, i'p)}{\omega_{ii'}(\mathbf{p})}\right]\left[R^0_{ii'}(p) + W^{0jj}_{i'i}(p, p') f^0_{jp'}\right] + \right.$$
$$+ \left[\frac{\mathbf{v}^0(ip, i'p)}{\omega_{ii'}(\mathbf{p})}\right]\left[R^1_{ii'}(p) + W^{0jj}_{i'i}(p, k)\left(W^0_{jk, j'k'}\right)^{-1}\bar{R}^1_{j'k'} + \right.$$
$$\left.\left. + W^{1jj}_{i'i}(p, k) f^0_{jk}\right]\right\}. \qquad (2, 13)$$

are obtained where

$$\sum W^0_{ii'}(\mathbf{p}, \mathbf{p}') f^0_{i'\mathbf{p}'} = -R^0_{i\mathbf{p}}, \qquad (2, 8)$$

$$\sum W^0_{i'i}(\mathbf{p}, \mathbf{p}') f^1_{i'\mathbf{p}'} = -\left[R^1_{i\mathbf{p}} + \sum W^1_{ii'}(\mathbf{p}, \mathbf{p}') f^0_{i'\mathbf{p}'}\right] = R^1_{i\mathbf{p}}, \qquad (2, 9)\ ;$$

$$W_{ii}(\mathbf{p}, \mathbf{p}') = W^{i'i'}_{ii}(\mathbf{p}, \mathbf{p}');$$

f_{ip} and R_{ip} are the diagonal parts of f and R, $R = R^0 + R^1$. In addition, the ferromagnetic Hall current is studied for limiting cases of higher and lower temperatures. In the former case, $I_\alpha \approx \gamma\sigma ME/\tilde{M}$ for (A') and $I_\alpha \approx \gamma\sigma\tau ME/\tau_D\tilde{M}$ for (B') where $\tilde{M} = \xi/A$, ξ is the Fermi energy, is obtained under the assumption that there is only one type of carriers. Hence

$$R_M = \gamma \frac{m}{ne^2\tilde{M}}\left(\eta_1 \frac{1}{\tau_D} + \eta_2 \frac{1}{\tau_D}\frac{\hbar}{\tau_p \xi} + \eta_3 \frac{1}{\tau_p}\frac{\hbar}{\tau_p \xi} + \eta_4 \frac{1}{\eta}\frac{\hbar}{\tau\sqrt{\xi\Delta}}\right), \quad (5,1)$$

and

$$\frac{R_M}{R_B} = \gamma \frac{mc}{e\tilde{M}}\left(\eta_1 \frac{1}{\tau_D} + \eta_2 \frac{1}{\sigma_D}\frac{\hbar}{\tau_p \xi} + \eta_3 \frac{1}{\tau_p}\frac{\hbar}{\tau_p \xi} + \eta_4 \frac{1}{\tau}\frac{\hbar}{\tau\sqrt{\xi\Delta}}\right). \quad (5,2)$$

are obtained for (A'). η_i are the numerical coefficients ($\gtrsim 0$). At high temperatures $R_M/R_B \sim (M\tau_F^2\bar{\varepsilon})^{-1}$, $\tau_F \ll \tau_D$. There are 4 figures.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute imeni A. F. Ioffe AS USSR, Leningrad)

SUBMITTED: March 22, 1962 (initially)
May 30, 1962 (after revision)

GUREVICH, L.E.; EFROS, A.L.

Effect of spin on Shubnikov - De Haas oscillations as a possible method for determining the effective mass of current carriers. Zhur. eksp. i teor. fiz. 43 no.2:561-563 Ag '62. (MIRA 16:6)

1. Fiziko-tekhnicheskiy institut imeni A.F.Ioffe AN SSSR.
(Quantum theory) (Electrons--Scattering)
(Magnetic fields)

GUREVICH, L.E.; YASSIYEVICH, I.N.

Theory of the ferromagnetic Hall effect. Fiz.tver.tela 4 no.10:2854-2866 O '62. (MIRA 15:12)

1. Fiziko-tekhnicheskiy institut imeni Ioffe AN SSSR, Leningrad.
(Hall effect) (Ferromagnetism)

GUREVICH, L.E.; IOFFE, I.V.

Some aspects of current instability in semiconductors. Fiz. tver.tela 4 no.10:2964-2970 O '62. (MIRA 15:12)

1. Fiziko-tekhnicheskiy institut imeni A.F.Ioffe AN SSSR, Leningrad.
(Semiconductors--Electric properties)

S/056/63/044/002/026/065
B102/B186

AUTHOR: Gurevich, L. E.

TITLE: Thermomagnetic waves and the excitation of a magnetic field in a nonequilibrium plasma

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 44, no. 2, 1963, 548-555

TEXT: The theories dealing with the origin of cosmic rays and cosmic radio waves usually assume the presence of strong magnetic fields, but without explaining the mechanism of their generation. In the present paper it is shown that the hydrodynamic motion in a non-equilibrium plasma in which there is a temperature gradient induces magnetic fields. The conditions can be such that parametric resonance for electrons and resonance acceleration of ions arise; this will be the case when in the shock waves such a magnetic field arises whose ionic Larmor frequencies are comparable with the oscillation frequency. It is shown that a plasma with temperature gradient displays oscillatory properties that differ considerably from those of an ordinary plasma. Even when no external

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magnetic field is present and no hydrodynamic motions take place, transverse thermomagnetic waves can arise in which only H will oscillate. If there is a constant external field $\hat{H}$, then the wave vector of the thermomagnetic waves must be perpendicular to it and lie in the $(\vec{H}, \nabla T)$-plane. The common Alfvén wave will split into two "hydrothermomagnetic" waves whose vectors $\vec{v}$ and $\vec{H}$ will be perpendicular to ∇T. The spectrum of the magnetosonic waves will change considerably when the propagation rate of the thermomagnetic waves becomes comparable with the sonic velocity and the velocity of the Alfvén waves. The thermomagnetic fields cause a magnetic field uniform with respect to ∇T to rotate in the direction of ∇T.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe Akademii nauk SSSR (Physicotechnical Institute imeni A. F. Ioffe of the Academy of Sciences)

SUBMITTED: June 29, 1962

GUREVICH, L. E.

V. L. Gurevich and L. E. Gurevich, "Plasma Effects in Semiconductors."

report submitted for the Conference on Solid State Theory, held in Moscow, December 2-12, 1963, sponsored by the Soviet Academy of Sciences.

GUREVICH, L.E.; VLADIMIROV, V.I.

Kinetic properties of a rarefied plasma with a high radiative pressure and the effects of mutual entrainment of electrons and photons. Zhur. eksp. i teor. fiz. 44 no.1:166-176 Ja '63. (MIRA 16:5)

1. Fiziko-tekhnicheskiy institut imeni A.F.Ioffe AN SSSR.
(Plasma (Ionized gases)) (Electrons—Scattering)
(Photons—Scattering)

L 13843-63 EWT(l)/EWG(k)/BDS/EEC(b)-2 AFFTC/ASD/ESD-3 Pz-4 65
AT/IJP(C)
ACCESSION NR: AP3003151 S/0056/63/044/006/2150/2158 64

AUTHOR: Gurevich, L. E.; Korenblit, I. Ya.

TITLE: Electrical conductivity and galvanomagnetic coefficients of semimetals and degenerate semiconductors in a strong electric field

SOURCE: Zhurnal eksper. i teor. fiziki, v. 44, no. 6, 1963, 2150-2158

TOPIC TAGS: electric conductivity, galvanomagnetic coefficients, phonon equilibrium, mutual electron-phonon drag, Hall conductivity

ABSTRACT: It is shown that the electrical conductivity and galvanomagnetic coefficients of semimetals and of degenerate semiconductors in a strong electric field are considerably modified if the phon system is not in equilibrium. The lack of phonon equilibrium is manifest in the "heating" of the phonons increase in the number of long-wave phonons in a strong electric field) and in the "mutual" dragging of the electrons and phonons. The first circumstance leads to a decrease in the mean free path of the electrons scattered by phonons when the field is increased, and is the cause of the dependence of the electric conductivity on the field strength in the zeroth approximation with respect to degeneracy. In a strong magnetic field the electric conductivity first increases with increasing electric field intensity, reaches a maximum, and at sufficiently high field

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L 13843-63

ACCESSION NR: AP3003151

strengths it decreases in inverse proportion to the field and is independent of the magnetic field strength; the current, on the other hand, increases monotonically and approaches saturation. The Hall conductivity decreases with increasing electric field and is proportional the inverse square of the field in sufficiently strong fields, whereas the Hall current exhibits a maximum. The deviation from Ohm's law in weak electric fields is negative in a weak magnetic field and reverses sign with increasing field, approaching zero in strong magnetic fields. The "mutual" drag of the electrons and phonons results in a considerable increase in the electron free path, leading to a decrease of the electric field at which the current saturates. Orig. art. has: 4 figures and 32 formulas.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe Akademii nauk SSSR (Physicotechnical Institute of the Academy of Sciences SSSR)

SUBMITTED: 14Feb63 DATE ACQ: 23Jul63 ENCL: 00

SUB CODE: 00 NO REF SOV: 006 OTHER: 001

Card 2/2

GUREVICH, L.E.; IPATOVA, I.P.

Temperature dependence of the line width of resonance absorption by the lattice in ionic crystals. Zhur. eksp. i teor. fiz. 45 no.2:231-236 Ag '63. (MIRA 16:9)

1. Fiziko-tekhnicheskiy institut imeni A.F.Ioffe AN SSSR.
(Ionic crystals—Spectra) (Quantum theory)

L 17227-63 BDS/EWP(q)/EWT(m)--AFFTC/ASD--JD

ACCESSION NR: AP3007078 S/0056/63/045/003/0576/0586

55
54

AUTHOR: Gurevich, L. E.; Nedlin, G. M.

TITLE: Thermal emf of ferromagnetic metals due to scattering of electrons on magnons 14

SOURCE: Zhur. eksper. i teoret. fiziki, v. 45, no. 3, 1963, 576-586

TOPIC TAGS: electron scattering, spin wave, magnon, thermoelectricity, Thomson effect, ferromagnetics, thermal emf, thermal electromotive force

ABSTRACT: The thermal emf of ferromagnetic metals has been studied at temperatures considerably above 1K but much below the Curie point for cases in which 1) electron scattering is due solely to spin waves and 2) scattering on defects predominates. It is shown that if scattering is limited to the spin-wave effect, the thermal emf in the zero approximation of degeneracy, $\alpha^{(0)}$, is on the order of that in the first approximation, $\alpha^{(1)}$. When scattering is due

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L 17227-63

ACCESSION NR: AP3007078

primarily to defects, $\alpha^{(0)}$ may equal or exceed $\alpha^{(1)}$. Unlike $\alpha^{(1)}$, $\alpha^{(0)}$ is dependent upon the effect of relaxation time on the defects. In particular, $\alpha^{(0)}$ is in this case inversely proportional to the concentration of defects, while $\alpha^{(1)}$ is independent of this concentration. Orig. art. has: 60 formulas.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe Akademii nauk SSSR (Physicotechnical Institute, Academy of Sciences SSSR)

SUBMITTED: 21Feb63 DATE ACQ: 08Oct63 ENCL: 00

SUB CODE: PH NO REF SOV: 007 OTHER: 000

Card 2/2

GUREVICH, L.E.; YASSIYEVICH, I.N.

Theory of the ferromagnetic Hall effect. Fiz. tver tela 5 no.9: 2620-2626 S '63. (MIRA 16:10)

1. Fiziko-tekhnicheskiy institut im. A.F.Ioffe AN SSSR, Leningrad.

GUREVICH, L.E.; IOFFE, I.V.

Theory of current instability in semiconductors and semimetals.
Fiz. tver tela 5 no.9:2674-2681 S '63. (MIRA 16:10)

1. Fiziko-tekhnicheskiy institut im. A.F.Ioffe AN SSSR, Leningrad.

GUREVICH, L.E.

Thermomagnetic waves and the excitation of a magnetic field in a nonequilibrium plasma. Zhur. eksp. i teor. fiz. 44 no.2:548-555 F '63. (MIRA 16:7)

1. Fiziko-tekhnicheskiy institut imeni A.F. Ioffe AN SSSR.

GUREVICH, L. E.; IPATOVA, I. P.; KLOCHIKHIN, A. A.

"Raman scattering and impurity absorption by the lattice of homopolar crystals."

report submitted for Intl Conf on Physics of Semiconductors, Paris, 19-24 Jul 64.

ACCESSION NR: AP4013503 S/0181/64/006/002/0445/0455

AUTHORS: Gurevich, L. E.; Ioffe, I. V.

TITLE: Theory of current instability in semiconductors exhibiting impact ionization

SOURCE: Fizika tverdogo tela, v. 6, no. 2, 1964, 445-455

TOPIC TAGS: current instability, semiconductor, impact ionization, ionization, electrical field, magnetic field, carrier concentration, recombination, intrinsic semiconductor

ABSTRACT: The authors have investigated the current instability in an intrinsic semiconductor in parallel electrical and magnetic fields under conditions such that impact ionization by the electrical field leads to the development of a transverse gradient in the concentration of carriers, which combine at the surface. A slight unparallelism of the electrical and magnetic fields may lead to amplification or extinction of the instability, depending on the direction of the applied field. The authors examined both platy and cylindrical samples, and they have

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ACCESSION NR: AP4013503

determined the critical field at which instability appears and the frequency of the amplified oscillation that arises. They found that the instability is generally drifting in character, but when mobilities are equal it is absolute. Spiral waves arose in the cylindrical sample at fields above the critical value. Orig. art. has: 1 figure and 17 formulas.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physical and Technical Institute AN SSSR)

SUBMITTED: 03Aug63 DATE ACQ: 03Mar64 ENCL: 00

SUB CODE: PH NO REF SOV: 010 OTHER: 009

Card 2/2

S/0181/64/006/003/0856/0863

ACCESSION NR: AP4019850

AUTHORS: Gurevich, L. E.; Korenblit, I. Ya.

TITLE: The effect of phonon drag on electrons and the effect of their "mutual" entrainment on the kinetic coefficients of semimetals

SOURCE: Fizika tverdogo tela, v. 6, no. 3, 1964, 856-863

TOPIC TAGS: phonon drag, entrainment, semimetal, semiconductor, thermoelectromotive force, electric conductivity, Nernst coefficient, degeneracy

ABSTRACT: The authors have solved kinetic equations for electrons and phonons in semimetals (or degenerate semiconductors) in an arbitrary nonquantized magnetic field, considering the entrainment of electrons by phonons and the mutual entrainment of electrons and phonons. They have investigated semimetals with carriers of a single sign and semimetals containing both electrons and holes, and they have obtained a formula for the effective electron path:

$$l_{eff}=\left(\frac{1}{l_d}+\frac{4}{k_\lambda+3}\frac{T}{sp}\frac{1}{L_{fd}(2p)}\right)^{-1}\gg l,$$

where l and L are the paths of electrons and phonons, respectively, with the

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ACCESSION NR: AP4019850

subscripts indicating mechanism of scattering (f - phonons, d - defects), T is absolute temperature, s the velocity of sound, and other symbols are standard. This expression is a refinement of the determination of Parrot for nondegenerate semiconductors. The authors have shown that the entrainment of electrons by phonons increases the thermoelectromotive force and increases the Nernst coefficient in semimetals with both types of carriers, up to values characteristic of nondegenerate electrons. Mutual entrainment may sharply increase electrical conductivity when no magnetic field is present, and both the conductivity and the Nernst coefficient are increased in strong magnetic fields. In addition, mutual entrainment substantially changes the temperature dependence. If the temperature dependence of the positive electron length is identical to the negative value, then the temperature dependence of the Nernst coefficient in strong and weak magnetic fields is the same as for a single type of carrier. Orig. art. has: 38 formulas.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute AN SSSR)

SUBMITTED: 02Oct63 DATE ACQ: 31Mar64 ENCL: 00

SUB CODE: EC, SS NO REF SOV: 005 OTHER: 004

Card 2/2

L 18855-65 EWT(l)/EWG(k)/EWT(m)/EWA(d)/EPR/EWP(t)/EEC(b)-2/EWP(b) Pc-4
AFWL/ASD(a)-5/SSD/AS(mp)-2/RAEM(c)/ESD(dp)/ESD(gs)/ESD(t)/IJP(c)/ JD/AT

ACCESSION NR: AP4043374 S/0181/64/006/008/2471/2477

AUTHORS: Gurevich, L. E.; Korenblit, I. Ya.

B

TITLE: Thermoelectromotive force in ferromagnetic metals at low temperatures and the drag of electrons by magnons

SOURCE: Fizika tverdogo tela, v. 6, no. 8, 1964, 2471-2477

TOPIC TAGS: thermal emf, phonon, magnon, ferromagnetic material, electron scattering, temperature dependence, low temperature transport

ABSTRACT: In ferromagnetic metals the thermal emf has electron, phonon, and magnon components. At the low temperatures considered here the magnon component is stronger than the phonon component and, at not too low temperatures, it may also be stronger than the electron component. The present paper deals with the longitudinal and transverse thermal emf allowing for the drag of electrons by moving magnons and for the mutual drag of the moving electrons and magnons.

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L 18855-65
ACCESSION NR: AP4043374

It is shown that if electrons are scattered mainly from defects
the total longitudinal thermal emf has an extremum in its dependence
on the applied magnetic field. In strong fields the electron compo-
nent of the transverse thermal emf decreases to zero while the mag-
non component remains finite and therefore dominates the effect.
If the electrons are scattered mainly from magnons, the thermal emf
can be found in the limiting cases of weak and strong magnetic
fields. The transverse thermal emf tends to saturate in strong mag-
netic fields. The longitudinal power may be a nonmonotonic function
of the magnetic field both in strong and in weak fields. A discus-
sion of the temperature dependence of the thermal emf shows that the
magnon component of the longitudinal effect is proportional to $T^{3/2}$
(T = temperature), while the electron component of the same effect
in weak magnetic fields is proportional to T, if electrons are scat-
tered mainly on defects, and proportional to T^{-1}, if electrons are
scattered mainly on magnons. Orig. art. has: 33 formulas.

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L 18855-65

ACCESSION NR: AP4043374

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR Leningrad (Physicotechnical Institute AN SSSR)

SUBMITTED: 23Mar64 ENCL: 00

SUB CODE: EM, SS NR REF SOV: 005 OTHER: 001

Card 3/3

L 6831-65
EWT(1)/EWG(k)/T Pz-6 IJP(c)/ASD(a)-5/AFWL/ESD(gs)/ESD(t)/RAEM(t) AT

ACCESSION NR: AP4044966 S/0181/64/006/009/2856/2857

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56

AUTHORS: Gurevich, L. E.; Gel'mont, B. L.

TITLE: Transverse galvanomagnetic waves and their detection by means of resonance phenomena

SOURCE: Fizika tverdogo tela, v. 6, no. 9, 1964, 2856-2857

TOPIC TAGS: galvanomagnetic wave, resonance, semiconductor, semimetal, carrier density

ABSTRACT: Referring to the observation of the oscillatory galvanomagnetic effect in metallic sodium by R. Bowers, C. Legendy, and F. Rose (Phys. Rev. Letters v. 7, No. 9, 339, 1961), the authors calculate from their data the impedance of the primary circuit of their test setup as a function of the frequency, and show that in addition to the maximum observed by Bowers et al., there is also a frequency corresponding to a minimum, at which the impedance changes from

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L 6831-65

ACCESSION NR: AP4044966

capacitive to inductive, and which was not taken into account at all. It is further pointed out that the galvanomagnetic-effect frequency can be observed not only in metals but also in semiconductors and semimetals having a single type of carrier, but owing to the lower carrier density the frequencies will be much higher. Orig. art. has: 5 formulas.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute, AN SSSR)

SUBMITTED: 13Apr64

ENCL: 00

SUB CODE: SS, EM NR REF SOV: 002 OTHER: 001

Card 2/2

L 12444-65 EWT(1)/EWG(k)/T Pz-6 IJP(c)/ASD(a)-5/SSD/AS(mp)-2/AFWL/ESD(gs)/ESD(t)
ACCESSION NR: AP4046599 AT S/0181/64/006/010/2926/2933

AUTHOR: Gurevich, L. E.; Ioffe, I. V.

B

TITLE: Galvanomagnetic waves and spontaneous current oscillations in semiconductors and in semimetals

SOURCE: Fizika tverdogo tela, v. 6, no. 10, 1964, 2926-2933

TOPIC TAGS: semiconductor, semimetal, galvanomagnetic wave, current oscillation, thermal oscillation, Hall effect

ABSTRACT: Galvanomagnetic waves are produced in solid conductors having carriers of both polarities whenever periodic density distributions, current densities, and field gradients are produced by external application of an electric field and a magnetic field. Estimates made for several field configurations (no magnetic field, magnetic and electric field parallel, magnetic field and electric field perpendicular) show that weakly damped galvanomagnetic waves with

L 12444-65
ACCESSION NR: AP4046599

wavelengths that can be realized in solids under laboratory conditions ($\lambda \leq 10$ cm) are feasible only in semiconductors or semimetals (frequencies about 10^5–10^6 sec^{-1}). If a carrier density gradient is produced by any factor in a direction perpendicular to the electric field, galvanomagnetic oscillations can be produced spontaneously by thermal oscillations. If the electric field is sufficiently strong, the galvanomagnetic oscillations may build up rather than attenuate, making the electric current in such a semiconductor unstable. An approximate theoretical analysis of this case is presented. It is shown, in particular, that instability due to one effect (for example, strong illumination) can sometimes be suppressed by another effect (for example, the Hall effect). Orig. art. has: 16 formulas.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute, AN SSSR)

Card 2/3

L 14843-65 EWT(1) IJP(c)/AFWL/SSD/AS(mp)-2/AFMDT/ESD(d)/ESD(gs)/ESD(t)

ACCESSION NR: AP4048410 S/0181/64/006/011/3341/3347

AUTHORS: Gurevich, L. E.; Yassiyevich, I. N.

TITLE: High-frequency ferromagnetic Faraday and Kerr effects 21

SOURCE: Fizika tverdogo tela, v. 6, no. 11, 1964, 3341-3347

TOPIC TAGS: Hall effect, Faraday effect, Kerr effect, spin orbit interaction

ABSTRACT: The authors investigate the high-frequency ferromagnetic Hall conductivity which causes the ferromagnetic Faraday and Kerr effects away from the interband resonance. Spatial dispersion is neglected. It is shown that at high frequencies the usual kinetic equation for the diagonal distribution function is not sufficient, and that terms due to the off-diagonal terms of the density matrix must be taken into account. The contribution of these terms is evaluated. It is shown that there are two frequency regions in which

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L 14843-65

ACCESSION NR: AP4048410

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the ferromagnetic Hall conductivity has different properties. At lower frequencies the ratio of the imaginary parts of the ferromagnetic and ordinary Hall conductivities is equal to the ratio of the real parts and is the same as in the case when the ferromagnetic Hall effect is due to asymmetrical scattering by magnons or defects. At higher frequencies the ratios are not equal. "The authors thank A. I. Voloshinskiy who pointed out the change in the role of interband transitions in the high-frequency case." Orig. art. has: 34 formulas.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute, AN SSSR)

SUBMITTED: 28May64 ENCL: 00

SUB CODE: SS, EM NR REF SOV: 005 OTHER: 003

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L 15059-65 EWP(m)/EWT(1)/EWG(k)/EPA(sp)-2/EWG(v)/EWA(d)/EPR/EPA(w)-2/EEC(t)/T-2/EEC(b)-2/EWA(m)-2 Pz-1/Pe-5/Po-4/Ps-4/Pi-4/Pz-6/Pab-10/Pae-2 LTP(c)/BSD/SSD(b)/AEDC(a)/SSD/ASD(a)-5/ASD(f)-2/AFWL/ASD(p)-3/AFETR/RAEM(a)/RAEM(c)/ESD(gs)/ESD(t) AT/GW

ACCESSION NR: AP4045270 S/0057/64/034/009/1597/1604

AUTHOR: Gurevich, L.E.; Gel'mont, B.L.

TITLE: Contribution to the theory of thermomagnetohydrodynamic waves in a weakly nonuniform plasma

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no. 9, 1964, 1597-1604

TOPIC TAGS: nonuniform plasma, weakly ionized plasma, wave propagation, magnetohydrodynamics, star

ABSTRACT: The authors have previously discussed the propagation of waves in a fully ionized plasma in a uniform magnetic field in the presence of small temperature and density gradients (ZhETF 44,548,1963; 46,884,1964). In the present paper they extend this discussion to the case of a weakly ionized plasma. The calculations are based on the magnetohydrodynamic equations of motion of a viscous gas, with terms in the expressions for the electric field and the heat flux to take account of the thermomagnetic current. The linearized equations for a harmonic perturbation were derived and the corresponding dispersion equation is written. In the derivation of the dispersion equation it was assumed that the period of the oscillations is long

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ACCESSION NR: AP4045270

compared with the electron mean free time, that the wavelength is short compared with the length characterizing the nonuniformity of the plasma, and that the magnetic pressure is small compared with the kinetic pressure. The solutions of the dispersion equation are discussed in detail, and conditions are derived for the stability of the different types of wave. It is found that in passing from a strongly ionized to a weakly ionized plasma the propagation direction of the thermomagnetic waves changes, and there is a region from which the waves are reflected. This situation occurs in stars, where the outer region is weakly ionized and the inner region is completely ionized. Both Alfven waves and thermomagnetic waves are found to be linearly polarized when the conditions for their stability are met, and to be elliptically polarized when they are unstable. The instability of the thermomagnetic waves in a strong magnetic field is discussed in the drift approximation for the case in which the temperature gradient is parallel to the applied magnetic field. The dispersion equation thus found is consistent with that obtained in the magnetohydrodynamic approximation. The drift theory shows that the instability of a plasma in a strong magnetic field in the presence of a temperature gradient is due to drift of particles occasioned by an inertial force acting on the ions. Orig. art. has: 61 formulas.

L 15059-65
ACCESSION NR: AP4045270

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physico-technical Institute, AN SSSR)

SUBMITTED: 02Dec63 ENCL: 00

SUB CODE: ME NR REF SOV: 005 OTHER: 001

ACCESSION NR: AP4025921 S/0056/64/046/003/0884/0901

AUTHOR: Gurevich, L. E.; Gel'mont, B. L.

TITLE: Hydrothermomagnetic waves in a weakly inhomogeneous plasma

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 46, no. 3, 1964, 884-901

TOPIC TAGS: plasma, plasma stability, global instability, local instability, hydrothermomagnetic wave, plasma temperature gradient, plasma density gradient, plasma dielectric constant, electron Larmor frequency, electron relaxation time, convective instability, absolute instability, poloidal field, totoidal field

ABSTRACT: Local instability, characterized by development of local fluctuations and considered by Rudakov and Sagedeyev (Yaderny*y sinetz, Appedix 2, 1952) for the case of a collisionless plasma, is considered in the case of hydrothermal magnetic waves in a weakly inhomogeneous plasma with a small temperature or density gradient or a constant electric field (the case of nonzero temperature gradient and a uniform weak magnetic field was considered by the author earlier in ZhETF v. 44, 548, 1963). The general equations obtained are rather complicated, and consequently the relation between this type of instability and the

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ACCESSION NR: AP4025921

instability of the system as a whole (global instability) is considered for the simplest case of a system with a dielectric constant that varies in one direction only and is nonvanishing in the entire region under consideration. It is shown that the appearance of a positive imaginary frequency component denotes the transition of the system from local to global instability. The character of the instability is examined for several values of $\Omega\tau$ (Ω -- electron Larmor frequency and τ -- electron relaxation time). When $\Omega\tau \ll 1$ the instability is convective, when $\Omega\tau > 1$ it is absolute. The growth rate of the instability is shown to be a maximum when the wave vector, the magnetic field vector, and the temperature gradient vector are parallel. The instability of hydrothermomagnetic waves in a weak magnetic field and in a strong magnetic field is also analyzed and the case when radiative thermal conductivity predominates is examined. It is shown that the presence of instability in an external poloidal field may give rise to a toroidal field and vice versa. This mechanism may be of significance in the creation of the magnetic field of celestial bodies. Orig. art. has: 65 formulas.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR (Physico-technical Institute AN SSSR)

SUBMITTED: 12Jul63 DATE ACQ: 16Apr64 ENCL: 00

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ACCESSION NR: AP4025938 S/0056/64/046/003/1056/1065

AUTHOR: Gurevich, L. E.; Nedlin, G. M.

TITLE: Singularities of thermomagnetic phenomena in ferromagnetic metals

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 46, no. 3, 1964, 1056-1065

TOPIC TAGS: ferromagnetic metal, thermomagnetic phenomena, electron magnon collision operator, operator symmetry, dependence on energy variables, thermal emf, Nerst coefficient, spin wave spectrum

ABSTRACT: This is a continuation of an earlier investigation (ZhETF v. 45, 576, 1963) of the special properties of the operator of collision between electrons and magnons in ferromagnetic metals, and particularly its symmetry as a function of the energy variables. A study of the influence of these operator characteristics on the

ACCESSION NR: AP4025938

thermomagnetic phenomena in weak and strong magnetic fields, when the Larmor frequency of the conduction electrons is respectively smaller and larger than the collision frequency, shows that the singularities of the electron-magnon collision operator leads to violation of certain universal properties of thermomagnetic coefficients which are characteristic of nonferromagnetic metals. It is assumed that the spin-wave spectrum does not depend on the magnetic field, and consequently the quantity which assumes the role of relaxation time is also independent of the magnetic field. The analysis is restricted to the calculation of the normal part of the thermal emf and of the Nernst coefficient, so that the results can be compared with experiment only under conditions when the normal part can be separated or is dominant. Orig. art. has: 42 formulas.

ASSOCIATION: Institut poluprovodnikov AN SSSR (Institute of Semiconductors, AN SSSR)

ACCESSION NR: AP4025938

SUBMITTED: 20Aug63

DATE ACQ: 16Apr64

ENCL: 00

SUB CODE: PH

NR REF SOV: 004

OTHER: 000

Card 3/3

ACCESSION NR: AP4042403 S/0056/64/047/001/0300/0310

AUTHOR: Gurevich, L. E.; Vladimirov, V. I.

TITLE: Kinetic properties of a plasma with high radiation pressure

SOURCE: Zh. eksper. i teor. fiz., v. 47, no. 1, 1964, 300-310

TOPIC TAGS: plasma electric conductivity, plasma thermal conductivity, electron ion scattering, mutual drag effect

ABSTRACT: The kinetic coefficients (electric and thermal conductivity tensors) of a plasma in a magnetic field have been investigated for the case in which electrons are scattered by ions and relaxation of photons is due to Compton scattering by electrons or due to absorption by electrons during collision with ions. The investigation shows that the "photon wind" may produce a strong electron drag effect highly influencing the thermal electromotive force. It also shows that scattering of photons by electrons which they drag along (mutual drag effect) also significantly influences the kinetic properties of plasma by changing its transverse thermal conductivity.

ACCESSION NR: AP4042403

Finally, the investigation shows that the perturbation theory for the probability of radiative processes in the presence of an external radiation field, as it is in this case, does not lead to a logarithmic infrared divergence and, therefore, the familiar methods for removing infrared divergence must be modified if an external radiation field is present. Orig. art. has: 25 formulas.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe Akademii nauk SSSR (Physicotechnical Institute, Academy of Sciences, SSSR)

SUBMITTED: 29Jan64 ATD PRESS: 3075 ENCL: 00

SUB CODE: ME, NP NO REF SOV: 001 OTHER: 002

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L 13491-65 EWT(d)/EWT(l)/EWT(m)/EWP(w)/EPF(c)/EPF(n)-2/EWA(d)/EWP(t)/EWP(b)
Pr-4/Pu-4 IJP(c)/AFWL/AFETR/SSD/ASD(a)-5 JD/WW

ACCESSION NR: AP4047904 S/0056/64/047/004/1367/1377

AUTHORS: Gurevich, L. E.; Yassiyevich, I. N.

TITLE: Kinetic properties of metals with paramagnetic impurities at low temperatures

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 47, no. 4, 1964, 1367-1377

TOPIC TAGS: low temperature research, electric conductivity, thermal emf, metal property, paramagnetic impurity

ABSTRACT: The electrical conductivity and thermal emf tensors are derived for metals in which the electrons are scattered by paramagnetic impurity ions oriented completely or partly by an external magnetic field. The cases of an electric field parallel and perpendicular to the magnetic field are considered. In the case of a parallel electric field the electric conductivity increases and ap-

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ACCESSION NR: AP4047904

proaches saturation with increasing magnetic field intensity, while the thermal emf does not vanish in the zeroth approximation in the degeneracy, but has an extremum when the orientation energy of the ions is equal to the thermal energy. The thermal emf tends to zero like $e^{-\eta}$ ($\eta = \mu_0 gHT$). In the case of an electric field perpendicular to the magnetic field the normal and whole electric conductivities can have maxima as functions of the magnetic field, while the longitudinal and transverse thermal emf have two extrema between which they reverse sign. In either case the maximum thermal emf may reach a value equal to the reciprocal of the electron charge. Orig. art. has: 53 formulas and 4 figures.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe Akademii nauk SSSR (Physicotechnical Institute, Academy of Sciences, SSSR)

SUBMITTED: 07Mar64 ENCL: 00

SUB CODE: EM, MM NR REF SOV: 002 OTHER: 004

Card 2/2

L 21829-65 EWT(1)/EWT(m)/EEC(t)/EWP(t)/EWP(b) Peb IJP(c) JD

ACCESSION NR: AP5000336 S/0056/64/047/005/1806/1813

AUTHOR: Gurevich, L. E.; Gel'mont, B. L.

TITLE: Thermomagnetic waves in a solid body

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 47, no. 5, 1964, 1806-1813

TOPIC TAGS: thermomagnetic wave, thermomagnetism, thermal emf, bismuth, copper

ABSTRACT: It is demonstrated that at sufficiently low temperatures in a number of metals and semi-metals thermomagnetic waves can be detected which are similar to those discovered earlier by one of the authors in a nonhomogeneous plasma with a temperature gradient (L. E. Gurevich, ZhETF, 44, 548, 1963). In the case of Bi and Cu, the waves appear at temperatures of the order of 20—30K and lower. Similarly, as was observed in a plasma, these waves in solids can show an increasing amplitude. In a weak magnetic field, when the Larmor frequency of electrons is much smaller than the frequency of collisions,

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ACCESSION NR: AP5000336

the instability is convective, while in a strong field it becomes absolute. In the case of one-sign carriers, the increase of the thermal emf resulting, for example, from the phonon-drag of electrons or from peculiarities in electron scattering, can change substantially the critical temperature gradient and the critical magnetic field, as well as the oscillation increment in the presence of the instability. If the number of carriers of both signs is equal, the thermal emf along with the oscillation increment can, in a strong magnetic field, increase markedly. In such a field, when the temperature is close to zero, the thermomagnetic waves turn into waves with quadratic spectra. Orig. art. has: 27 formulas.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe (Physical-Technical Institute)

SUBMITTED: 24Apr64 ENCL: 00 SUB CODE: ME, EM

NO REF SOV: 007 OTHER: 002 ATD PRESS: 3166

Card 2/2

L 16100-65 EWT(1)/EWG(k)/EWT(m)/EPA(sp)-2/EPA(w)-2/EEC(t)/T/EEC(b)-2/EWA(m)-2 Pz-6/Po-4/Pab-10/Pt-10/Pi-4 IJP(c)/ESD(gs)/ESD(t)/AEDC(b)/SSD/BSD/AFWL/ASD(a)-5/ASD(p)-3 AT

ACCESSION NR: AP5000340 S/0056/64/047/005/1829/1831

AUTHORS: Gurevich, L. E.; Rumyantsev, A. A.

TITLE: Acceleration of charged particles by a radiation flux

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 47, no. 5, 1964, 1829-1831

TOPIC TAGS: charged particle acceleration, plasma acceleration, Compton scattering, electron photon scattering

ABSTRACT: The acceleration of charged particles by a radiation flux, resulting from the Compton scattering of the photons of the flux by the electrons, is discussed. In this mechanism the electrons scatter the photons multiply and are dragged by the photons. Since the electrons transfer momenta to the nuclei either by collision or via the electric field, they can accelerate in this manner an entire plasma layer (for example, the outer layer of a star). An

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ACCESSION NR: AP5000340

equation is derived for the rate of change of momentum produced by a spherically symmetrical radiation flux incident from the outside on a spherical plasma layer. The equation is solved for the case of a very thin layer. It is shown that the nuclei can acquire an energy on the order of their rest energy by this mechanism, at radiation fluxes that can be realized in nature in the case of supernova explosions. It is also shown that in the presence of a magnetic field the accelerated particles will remain localized near the star and this process can serve as a mechanism for injection of fast electrons and nuclei. Orig. art. has: 4 formulas.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe Akademii nauk SSSR (Physicotechnical Institute, Academy of Sciences SSSR)

SUBMITTED: 05May64 ENCL: 00

SUB CODE: NP, ME NR REF SOV: 003 OTHER: 000

Card 2/2